CHAPTER 3

PHOTOGRAPHIC FILTERS

Filters are used in all the various steps of the photographic process. Though often neglected in the shooting stage, the use of filters can tremendously enhance the final product in both black-and-white and color photography.

PURPOSE OF PHOTOGRAPHIC FILTERS

The purpose of photographic filters is to alter the characteristics of light that reaches the light-sensitive emulsion As light is transmitted through a filter, at least one of the following alterations occurs:

1. The color of light is modified.
2. The amount of light is reduced.
3. The vibration direction of the light rays is limited.

The two most important reasons for using photographic filters are to create an effect with an emulsion and to control the exposure of an emulsion. Interlocked with the use of filters are characteristics of light and characteristics of photographic emulsions. The effectiveness of a filter depends upon the ability of an emulsion to respond to the color of light transmitted by the filter.

Colored filters modify the way colors are recorded. Without the use of filters, black-and-white panchromatic film records colors as gray tones. These gray tones correspond roughly to the tonal range as seen by the human eye. Colored filters selectively brighten or darken these tones. In color photography, colored filters are used to correct or distort color balance.

Filters of a specific color transmit most of the light of that color and partially or completely absorb light of all other colors. For example, a red filter transmits red light and may partially or completely absorb blue and green light, depending on the deepness or purity of its color (fig. 3-1). Likewise, a yellow filter transmits red and green light and partially or completely absorbs blue light. Remember, a secondary color of light is produced by combining two primary colors of light. Red and green equal yellow; thus a yellow filter passes red and green light.

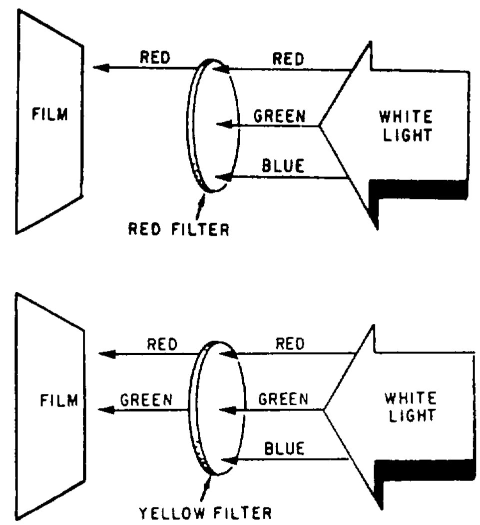

Figure 3-1.–Red and yellow filters.

Filters are available in three forms: optical glass disks bound with metal rims, lacquered gelatin film squares, and glass squares. Glass disk filters are the most practical for general use. They are available in different sizes called series numbers, such as Series 4,5, and 6 or in millimeter sizes, such as 52mm and 59mm. Glass disk filters attach to a camera lens in two ways. Some have threads and screw directly into the lens barrel, and the others are held on the lens barrel by an adapter ring. Gelatin filters and square filters made of glass are either inserted into special filter holders that are part of the camera, or they are held on the camera by a square filter holder.

FILTER DESIGNATIONS

Filters are usually identified by numbers. This system of designating filters is used to identify Kodak Wratten filters. It uses designators, such as No. 6, No. 8, and No. 11. Some filters have a descriptive name rather than a number; for example, polarizing, skylight, and neutral density. Color compensating and color print filters have yet another designation system.

FILTERS FOR BLACK-AND-WHITE PHOTOGRAPHY

Filters used with black-and-white film are classified as contrast, correction, and special purpose. All contrast and correction filters have a noticeable color. It is important to note that a filter must be used with an emulsion sensitive to the specific color of light it transmits. Colored filters should normally be used with black-and-white film only.

Special-purpose filters for black-and-white film may be colorless, contain a hint of color, be noticeably colored, or almost visually opaque. Some special-purpose filters can be used with both black-and-white and color film. Special-purpose filters are covered later in this chapter.

Contrast Filters

Contrast filters are available in all colors and are designed to exaggerate, reduce, or eliminate specific colors of light. As their name indicates, these filters are used to increase or decrease contrast in a negative that provides differences between tones in the print.

To illustrate this, compare a red apple and a yellow banana in a black-and-white print. With a red filter over the camera lens, the apple appears lighter on the print than the yellow banana. Both objects in this example reflect the same intensity of light.

When you look through a red filter, the filter definitely appears red. This color is the effect it produces in your eye and the reason it is called a red filter. The red filter is transmitting most of the red part of the spectrum, some yellow, and some magenta. The color it is not transmitting is cyan. If you think of this red filter as an anticyan (blue and green) filter, you will better understand the way it works.

When a red filter is used, most of the reflected red light from the red apple is transmitted through the filter and recorded as a dense area on the film. Only a portion of the yellow light is transmitted, so it is recorded as a less dense area on the film. Only some of the yellow light is transmitted because the reflected light from the banana consists of red and green light. Although the red portion of the yellow light is readily transmitted through the red filter, the green portion is absorbed to some degree. Thus less light from the yellow banana reaches the film emulsion.

When the negative is printed, the two print images have separation in contrast because of the differences in negative densities. The print image of the apple is lighter than the print image of the banana because the negative image of the red apple is more dense than the negative image of the yellow banana.

When using a specific color of contrast filter to provide separation between black-and-white images of colored objects, you should also take into account what effect the filter has on the images of other colored objects in the scene. For example, when there are blue and green objects in the scene, the red filter absorbs some or all of the reflected blue and green light. The red filter renders the negative images of these objects as low-density areas. Thus the print images have darker tones or densities.

Contrast filters can also be used to filter out an image or filter out the image of a transparent stain on an original document by copying it. This filtering-out process takes place by blending or matching the density of the image to be filtered out with the image density of the surrounding area For example, to eliminate the image of a yellow line on a white background, use a yellow filter. The yellow filter should be as deep (same color density) or deeper in color than the color of the line. The yellow filter reduces the intensity of the light reflected from the white background by absorbing blue light. The intensity of the light reflected from the yellow line is not greatly affected since the yellow filter readily transmits the yellow light. The reduction of the intensity of the light reflected from the white background and the intensity of the light reflected from the yellow line produces equal densities on the negative and thereby does not render an image of the yellow line. Conversely, when the yellow line is on a black background, a blue filter does not allow yellow light to be transmitted. Therefore, light from the yellow object is not allowed to affect the film emulsion. Thus the line appears as a thin area that matches the black background and is thereby "eliminated"

Stains on a drawing or a picture can be filtered out whenever the stain is transparent and reasonably pure in color. The filter should be approximately the same color as the stain. The stain may still show in the negative but, in the case of line material, proper paper contrast and printing exposure get rid of the rest of the stain image.

Remember, the color of filter required to eliminate the image of an object or stain is determined by the color of the object or stain and the darkness or lightness of the surrounding scene area. Also, always use a filter that is as deep or deeper in color than the color of the object or stain to be eliminated. Refer to table 3-1 for clarification on ways to use contrast filters.

Table 3-1.–Parallel Filter Bars

Filter Color and No.		Filter Color and No.	
Deep Red	29	Bluish Green	65
Red	25	Bluish Green	65
Light Red	23A	Cyan	4
Orange	21	Cyan	44
Deep Yellow	15	Blue	47
Yellow	8	Deep Blue	47B
Yellowish Green	11	Violet	34A
Yellowish Green	13	Violet	34A
Green	58	Magenta	33
Green	61	Magenta	33

Use the parallel filter bars to choose contrast filters for black-and-white photography. Adjacent filters lighten colors next to them. Opposite filters darken colors in the print; for example, a yellowish green No. 11 filter lightens subjects that are yellowish green or yellow and darkens subjects that are violet. A No. 44 cyan filter lightens blue and blue-green and darkens light red and orange.

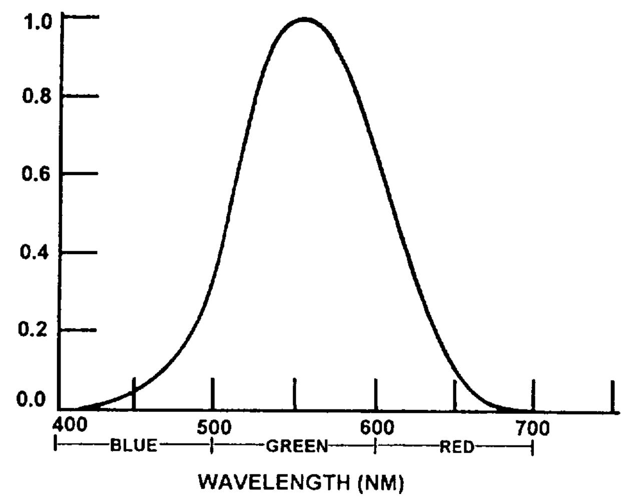

Figure 3-2.–Color sensitivity of the average human eye.

Correction Filters

Although panchromatic film responds to all the colors the eye can see, it does not reproduce tones of red, green, and blue objects in the same relative values as the eye sees them. The human eye is much more sensitive to green than it is to blue and red, and these colors look darker to the eye than green (fig. 3-2). Panchromatic film is more sensitive to blue and violet and looks lighter than green in a black-and-white print. This high sensitivity to blue and violet causes an overexposure to the film of blue objects as compared to green objects. This overexposure causes a dense negative image that results in a light print image (fig. 3-3).

A No. 8 yellow filter with panchromatic film helps to reproduce colors of a daylight scene with the same brightness relationship as seen by the human eye.

When using tungsten lighting, you can use a yellowish green No. 11 filter to reproduce the natural brightness relationship with panchromatic film. The yellow in the filter absorbs the ultraviolet radiation and some of the blue light, while the green in the filter absorbs some of the red light.

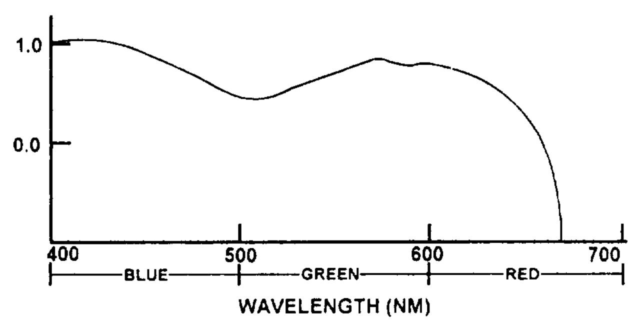

Figure 3-3.–Color sensitivity of panchromatic film.

Table 3-2.–Recommended Filters for Use with Black-and-White Panchromatic Film in Daylight

Subject	Desired Effect	Filter to Use	
Blue Sky	Natural	Yellow	No. 8
	Darken	Deep yellow	No. 15
	Very dark	Red	No. 25
	Near black	Deep red	No. 29
Seascape when sky is blue	Natural	Yellow	No. 8
	Dark water	Deep yellow	No. 15
Sunset	Natural	None/yellow	No. 8
	Brilliance	Deep yellow	No. 15
		Red	No. 25
Landscapers	Added haze for distant effect	Blue	No. 47
	Natural	Yellow	No. 8
	Reduce haze (little)	Deep yellow	No. 15
	Reduce haze (a lot)	Red	No. 25
		Deep red	No. 29
Green colors	Natural	Yellow	No. 8
	Light	Green	No. 58
Reddish colors	Lighter	Red	No. 25
Bluish colors	Lighter	Blue	No. 45
Wood, stone, sand, snow, fabrics, etc.	Natural	Yellow	No. 8
	Render texture	Deep yellow	No. 15
		Red	No. 25

To obtain desired effects with the use of filters, refer to table 3-2.

FILTERS FOR COLOR PHOTOGRAPHY

Problems associated with color materials are quite different from those encountered with black-and-white materials. In color photography, the main problem is achieving correct color balance. The principal factor involved is the color temperature of the light source being used to illuminate the subject. This color temperature provides a natural appearance to the final product. Filters for color photography are classified as light balancing, conversion, and color compensating.

LIGHT BALANCING FILTERS

Light balancing filters come in two series (not to he confused with a series that indicate physical size): the Series 81, yellowish filters, are used to lower the color temperature of a light source; and the Series 82, bluish filters, are used to raise the color temperature of light from a light source. Both series are used when a tungsten light source is used with color film.

These two series of filters permit minor adjustments in the color quality of an exposing light to obtain cooler (bluer) or warmer (more yellow) reproduction of colors; for example, when the color temperature of a tungsten light source is 3100 K and a color temperature of 3200 K is desired for the exposing light, a Series 82

Table 3-3.–Light Balancing filters

Filter color	Filter number	To Obtain 3200 K from:	To Obtain 3400 K from:
	81	3300 K	3510 K
	81A	3400 K	3630 K
	81B	3500 K	3740 K
Yellowish	81C	3600 K	3850 K
	81D	3700 K	3970 K
	81EF	3850 K	4140 K
	82C+82C	2490 K	2610 K
	82C+82B	2570 K	2700 K
	82C+82A	2650 K	2780 K
Bluish	82C+82	2720 K	2870 K
	82C	2800 K	2950 K
	82B	2890 K	3060 K
	82A	3000 K	3180 K
	82	3100 K	3290 K

color balancing filter can be used to raise the color temperature 100 K. Light balancing filters affect the entire visible spectrum of tungsten light and provide an adjustment from one Kelvin temperature to another.

When the color temperature of a tungsten light source is unknown, you can use a color temperature meter to determine it. When trying to determine what light balancing filter to use for producing a particular color temperature with a given light source, you may use the following methods:

1. Refer to the scale on a color temperature meter.
2. Refer to the tables in the *Photo-Lab-Index.*
3. Consult the manufacturer's publication for a particular filter or meter.
4. Consult appropriate film or filter data sheets.

Light balancing filters are Series 81 and Series 82. Refer to table 3-3 to determine light balancing filters that can be used to raise or lower the color temperature of a given color.

CONVERSION FILTERS

Conversion filters are used in color photography when a significant adjustment of an exposing light is required to convert the color quality of the exposing light to the color temperature for which a film is balanced.

Conversion filters generally come in two series. The 80 series of filters are blue in color and convert tungsten light to color qualities acceptable for use with daylight film. The 85 series of filters are amber in color and convert daylight to color qualities acceptable for use with tungsten film.

The correct filter to use for a given situation with a given film can most accurately be determined by consulting conversion filter tables in the *Photo-Lab-Index* or reading the filter and film data sheets.

COLOR COMPENSATING FILTERS

Color compensating (CC) filters are used to adjust the overall color balance obtained from color film, particularly slide film. Without the use of color compensating filters, improper color cast can result.

For cameras, CC filters are normally used to color balance the light from sources, such as fluorescent, tungsten, and mercury-vapor lights, and the "bounce" light reflected from colored surfaces. They are also used to balance lighting effects under unusual circumstances; for example, underwater lighting. These filters can be used to compensate for a known color deficiency of an unexposed color film. They can also be sandwiched (layered) when mounting a color transparency to compensate for an off-color hue.

Table 3-4.–Filters and Exposure Increase for Making Color Pictures by Fluorescent Light

Type of fluorescent lamp	Type of color film	
	Daylight	Tungsten
Cool White	30M + 2/3 f/stop	50M + 60Y + 1 1/3 f/stops
Deluxe Cool White	30C + 20M + 1 f/stop	10M + 30Y + 2/3 f/stop
Standard Warm White	40C + 40M + 1 1/3 f/stops	30M + 20Y + l f/stop
Deluxe Warm White	60C + 30M + 1 2/3 f/stops	10Y + 1/3 f/stop
White	20C + 30M + 1 f/stop	40M + 40Y + 1 f/stop
Daylight	40M + 30Y + 1 f/stop	No. 85B + 30M + 10Y + 1 f/stop

Whenever possible, you should conduct photographic tests in advance, using the type of light you expect to encounter. Consult the *Photo-Lab Index* for the most accurate filtration to use for your film, filter, and lighting situations. Table 3-4 provides an example of a good starting point for test exposures. When in doubt, you should use a filter that provides for average correction. For daylight film, you should use a 30M filter with a 2/3 f/stop exposure increase. For tungsten film, you should use a 50R filter and a 1 f/stop exposure increase.

CC filters may be used alone or in various combinations. However, when you use them in combination, the maximum number of filters in front of a lens should not exceed three. More than three filters adversely affect image quality. When combining CC filters, you should avoid creating a neutral density effect. Neutral density is caused when all three of the primary colors are present in the combined filters; for example, a cyan (blue and green) filter and a red filter.

CC filters are available in blue, green, red, yellow, magenta, and cyan. Each color is available in a range of densities. The color and density of a CC filter are identified in the filter designation, such as CC50Y. The CC indicates color compensating, the 50 indicates a peak density of 0.50 to blue light, and the Y is the first letter of the filter color-yellow. The peak density of a CC filter refers to the maximum absorption of the color of light that is complementary to the color of the filter. CC filters are available only in gelatin squares.

The color star (fig. 3-4) indicates various color relationships of color compensating filters as follows:

1. Complementary colors are opposite each other: cyan is complementary to red, yellow is complementary to blue, and magenta is complementary to green.

2. Any one color is a combination of the two colors adjacent to it:

R = M + Y

Y = R + G

G = Y + C

C = G + B

B = C + M

M = B + R

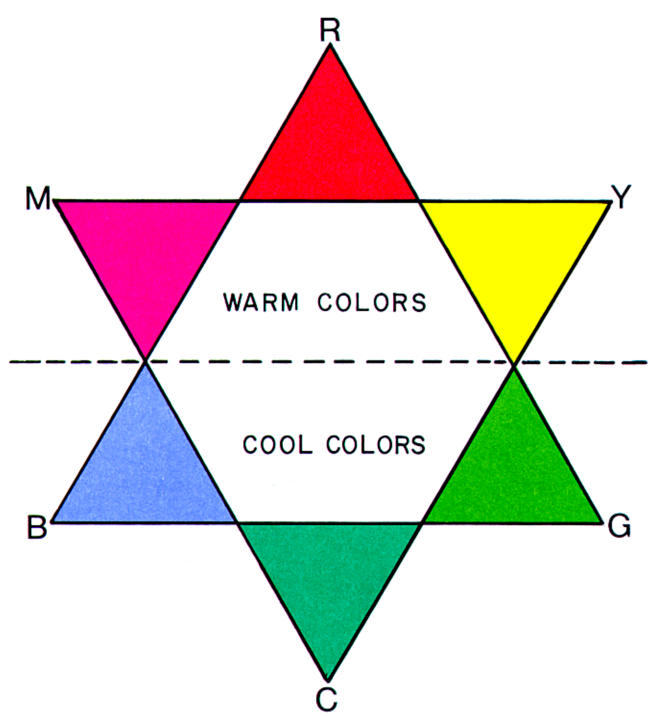

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Figure 3-4.–Color star.

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3. The warm colors are at the top of the horizontal axis. The cool colors are at the bottom.

4. Filters of the same color are added and subtracted normally:

30M + 20M= 50M

10B - 05B = 05B

5.When two filters of different colors and equal densities are combined, the color of the combined filters changes, but the peak density remains the same.

10M + 10C = 10B

10R + 10G = 10Y

6. A filter combination having all three primary colors creates neutral density. To correct this neutral density, subtract the lowest density from each color.

10R +	20G +	30B
-10	-10	-10
0R +	10C +	20B (Results)

SPECIAL-PURPOSE FILTERS

Special-purpose filters for use with black-and-white film are those filters not classified specifically as contrast or correction filters. Some of the special-purpose filters can be used with both black-and-white and color film. Two of these special-purpose filters are intended primarily for use with color film.

NEUTRAL DENSITY FILTERS

Neutral density (ND) filters reduce the amount of light passing through a camera lens without changing the reproduction of colors in the scene. These filters are nonselective in their absorption of colors of light and therefore uniformly reduce the various colors of light in the spectrum. Thus white light and colored light are transmitted through an ND filter with only the intensity of the light being affected. These filters can be used with both black-and-white and color film. Neutral density filters are gray in appearance. These filters may be needed for pictures being made of a brilliant subject in bright sunlight. When you have set the fastest shutter speed and the smallest f/stop and still cannot make the picture without overexposing the film, you can use an ND filter to further reduce the exposure. Neutral density filters manufactured by Kodak are called Wratten Neutral Density Filters and are available in several densities. The ten most popular densities, with the amount of exposure reduction provided, are shown in table 3-5.

Table 3-5.–Neutral Density Filters

Density	Exposure reduced by f/stops
.10	1/3
.20	2/3
.30	1
.40	1 1/3
.50	12/3
.60	2
.70	2 1/3
.80	2 2/3
.90	3
1.00	3 1/3

When you desire to reduce the depth of field but maintain a given shutter speed, ND filters permit the use of a larger f/stop which in turn, reduces the depth of field. Neutral density filters are used extensively in motion-picture photography where depth of field is usually quite deep. ND filters are also used with mirror type of lenses where there is no aperture control.

HAZE FILTERS

Suspended in the earth's atmosphere are minute particles of vapor and dust that cause a veil-like appearance called haze. This haze is most apparent in distant scenes. Haze is the result of sunlight being scattered by minute particles of matter that are present in the air. The amount of haze can vary due to atmospheric conditions. Haze should not be confused with mist, fog, smog, smoke, or clouds. These conditions can also produce a veil-like appearance, but filters have no effect.

When sunlight is scattered, both green light and red light are also scattered by the ever-present haze, but not nearly as much as ultraviolet radiation, violet, and blue light.

When filters are used to absorb scattered sunlight, penetration of the haze is possible. A haze filter is any filter that absorbs atmospherically scattered sunlight. A haze filter includes contrast and correction filters. When contrast and correction filters are used for haze penetration, they may be considered special-purpose filters. Although contrast filters can be used for cutting haze, these filters affect the gray tone rendering of colored objects. The contrast and correction filters that absorb the shorter wavelengths are the most effective. The recommended contrast and correction filter colors, in the order of greatest to least effective for haze penetration, are as follows:

Red

Orange

Yellow

Green

The use of an infrared sensitive black-and-white film with an infrared filter provides the greatest haze penetration of all. Special, visually opaque infrared filters completely absorb the scattered ultraviolet radiation and the visible light that produce haze. This absorption by an infrared filter allows the scene to be photographed entirely with unscattered infrared radiation. An infrared sensitive black-and-white film without an infrared filter, or at least a red contrast filter, is not effective for haze penetration. Infrared black-and-white film is sensitive to ultraviolet radiation, violet, and blue light as well as infrared radiation and red light. The gray tone rendering of a colored subject in a black-and-white print produced from an infrared negative is greatly distorted or contrasty.

The visually opaque infrared filters are identified by numbers as follows:

87

87A

87B

87C

88A

89B

When the effect of haze is to be reduced with an equal change to the gray tone rendering of all colored objects in a black-and-white print, filters that primarily absorb ultraviolet (UV) radiation are required. These filters have a very pale pink or yellow tint and may be identified by numbers as follows:

2A

2B

2C

2E

Colorless haze or ultraviolet absorbing filters are often used to protect the front element of a lens from damage. It is much cheaper to replace a filter than it is to repair or replace a lens.

The polarizing filter is another type of special-purpose filter that can be used to reduce the effects of haze.

POLARIZING FILTERS

Polarizing filters look like gray neutral density filters. However, their effect becomes apparent when you look at the blue sky through a polarizing filter while rotating it. As you rotate the filter, the sky appears to get darker, then lighter.

Polarizing filters are used in black-and-white and color photography for the following reasons:

1. Reduction or elimination of unwanted reflections (glare) from nonmetallic surfaces, such as glass and water

2. Exposure control, similar to ND filters

3. Reducing the effects of haze

4. Darkening the blue-sky image in both black-and-white and color photography

5. Increasing color saturation in a color photograph without altering the hues of image colors

As discussed in chapter 1 of this training manual, the term *polarize* refers to a property of light that cannot be seen-the direction in which light rays vibrate. Unpolarized light rays vibrate in all directions at right angles to the ray itself. A light ray is polarized when vibrations are in one direction only.

Any synthetic material that polarizes light may be called a polarizer, or polarizing device. A polarizing screen is a polarizer in sheet form.

There are a number of different polarizing filters. However, there are only two main types: one type fits over the camera lens and the other is designed to be used over a light source. Since they do not affect color, polarizing filters and screens may be used for both black-and-white and color photography. A polarizing device used over the camera lens may have small posts (known as indicator handles) projecting from the rim for aligning the axis of the polarizing grid.

The polarizing filter may be thought of as a screen, with an optical grid or slots, that stops all light that is not vibrating in a plane parallel to the axis of the grid lines.

As the filter is rotated, the amount of polarized light can be controlled. When the rodlike crystals are perpendicular to the vibration direction of the light, the polarized light is greatly absorbed. When the rodlike crystals are parallel to the vibration direction of the polarized light, the polarized light is almost totally transmitted.

Because polarizing filters are colorless, they can be used as neutral density filters. Even when polarized light is not present in a scene, polarizing filters can be used to reduce the intensity of light. When two polarizing filters are used, their combined densities can be varied considerably.

In color photography, the only way you can reproduce the sky darker without affecting the other colors in the scene is to use a polarizing filter. You can achieve various effects from light sky to dark sky by rotating the fiter to various positions. You can see this effect by viewing the scene through the viewfinder of a single-lens reflex (SLR) camera or by viewing the scene through the ground glass of a view camera. To see how much reflection control you are getting, rotate the filter as you are viewing the scene.

Getting the maximum effect with a polarizing filter depends on your angle to the subject as well as the rotation of the filter. When the reflection cannot be completely eliminated, try changing your camera angle to the subject. The maximum control of unwanted surface reflections and greatest reduction of light intensity occurs when two polarizing filters are used with their optical grids perpendicular to each other. This arrangement can be either two filters in tandem in front of the camera lens or one filter in front of the light source and another filter in front of the camera lens. You cannot control reflections from bare metal surfaces because the reflected light is not polarized.

SKYLIGHT FILTERS

By absorbing ultraviolet radiation, a skylight (1A) filter adds warmth to a scene recorded on a color transparency film. It does this by reducing the bluish cast prevalent in distant scenes and in scenes photographed on heavily overcast days or in open shade. A skylight filter is used primarily with daylight color reversal film exposed under the above conditions. A skylight filter is light pink in color.

FILTER FACTORS

Filters function by absorbing a portion of the light reflected from the subject to the camera. To compensate for this absorption and the loss of light, you may have to increase the exposure to compensate for the light absorbed by the filter. A numerical value is assigned called a “filter factor” or multiplying factor. This numerical factor is based on several variables that include the color sensitivity of the film, density of the filter, color of the filter, and color temperature of the light source. As these variables change, the filter factor also changes to produce the correct exposure consistently. Filters are often identified as “2 X yellow” or “4 X orange.” That implies that the filter factor is 2 and 4, respectively. Remember, the filter factor does not always remain constant when conditions change.

For example, a blue filter used with panchromatic film exposed with daylight requires a smaller filter factor than when the same film and filter are used with tungsten light. The reason for this is daylight has a higher content of blue light that is readily transmitted by the blue filter. Thus, with the same film and filter combination and with the same camera shutter speed and f/stop, more exposing light is available at the film plane with daylight as compared to tungsten light.

A filter that absorbs a great amount of illumination from a given light source is assigned a larger filter factor. A filter that absorbs a lower amount of illumination from the same light source is assigned a smaller filter factor.

To obtain the necessary light at the film plane for correct exposure with a filter, you must increase the original calculated exposure (without a filter). This increase in exposure is determined with a filter factor. When a filter has a factor greater than 1, an adjustment to the exposure must be made.

There are three general methods of using filter factors to determine the exposure increase required:

1. Divide the ISO speed by the filter factor, and use the product as the effective film speed.

Example: If the filter factor is 2 and the IS0 speed of the film is 100, the effective film speed is 50 (100 + 2 = 50).

Thus setting a film speed of 50 on your light meter produces the equivalent of 1 f/stop of additional exposure.

2. Determine the required exposure without the use of a filter; then multiply the unfiltered shutter speed by the filter factor.

Table 3-6.–Filter Factor Equivalent Exposure Table

Filter factor	Open lens aperture (f/stop)	or if the "unfiltered" shutter speed is									
		1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000
		Use a "filtered" shutter speed of									
2	1	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500
4	2	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250
8	3	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125
16	4	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60

Example: The unfiltered exposure calls for l/60 second, and the filter factor is 3. The correct exposure is 1/20 second (1/60 x 3 = 1/20 second). However, most cameras do not have a 1/20 second shutter speed; therefore, use 1/15 second or the next slowest shutter speed.

3. When you are using an SLR camera with through the lens (TTL) metering, put the filter on the camera lens and adjust the exposure in the normal manner. However, certain dark blue, red, and orange filters may give faulty readings if used with TTL metering systems because the meter reads 18 percent gray. The camera light meter may not be sensitive to the color of light passed by the filter.

4. Consult a filter factor equivalent exposure table. (See table 3-6.)

DARKROOM FILTERS

No types of filters are used almost exclusively in the photographic darkroom. They are safelight filters and printing filters. The printing filters include variable contrast filters for printing black-and-white materials and color printing filters for printing color materials.

SAFELIGHT FILTERS

The word *safelight* in photography is used to describe filtered tungsten illumination or direct illumination from a sodium-vapor lamp. The color of a sodium-vapor lamp does not affect (expose) light-sensitive materials under prescribed darkroom conditions. The word *safe* is misleading since light-sensitive materials are never completely safe from safelight illumination. The use of a safelight with some types of light- sensitive materials is not recommended Compatible safelight filters for use with certain light-sensitive materials should be selected on the basis of color sensitivity and emulsion speed of the material. The best method of selecting a darkroom safelight filter is to use the filter recommended by the manufacturer of the light-sensitive material. Safelight filters absorb that portion of the visible spectrum produced by a tungsten lamp that would affect the light-sensitive material being handled.

Sodium-vapor lamp safelights use sodium gas to provide safelight illumination. Incandescent sodium gas produces a very narrow band of visible light in the yellow-orange portion of the spectrum. Colorblind printing papers are not sensitive to this monochromatic (one color) band of light, whereas the human eye is very sensitive to it. Therefore, a brighter print room is possible without the light affecting the printing paper. By using specially designed filters that further reduce the narrow band of sodium-vapor light, black-and-white materials sensitive to green and red light can be handled under this illumination. Table 3-7 provides some examples for the application of safelight filters. Always consult the *Photo-Lab-Index* to determine the best safelight for use with various light-sensitive materials.

VARIABLE CONTRAST PAPER PRINTING FILTERS

To obtain various degrees of contrast using variable contrast printing papers, use a series of magenta and yellow filters. The magenta filters are used to print black-and-white negatives that are low in contrast.

Table 3-7.–Safelight Filters

Filter Designation	Color	Use With
OA	Greenish Yellow	Black-and-white contact and duplicating materials and projection films
OC	Light Amber	Printing papers
No. 1	Red	Blue sensitive films
No. 1A	Light Red	Orthochromatic copy films
No. 2	Dark Red	Orthochromatic films
*No. 3	Dark Green	Panchromatic films

NOTE

*Use caution when processing panchromatic film under a No. 3 safelight. When a No. 3 safelight is used, the film should not be exposed to it until at least half of the developing time has passed. Then the film should be examined quickly at a distance of about 36 inches from the safelight. Much experience is needed to judge proper negative development by the process of inspection, and it is rarely performed.

Yellow filters are used to print black-and-white negatives that are high in contrast. Variable contrast printing filters are discussed in chapter 10 of this TRAMAN.

FILTERS FOR COLOR PRINTING

Filters used to print color are as follows: color compensating (CC), color printing (CP), ultraviolet absorbing, and dichroic. Each one of these filters is discussed below.

Color Compensating Filters

The color compensating filters used for printing color materials are the same CC filters used with color film. These filters are used to modify the color quality of the exposing light needed to print the color negatives or transparencies. CC filters are used between the lens and the paper in the color printing process. These CC filters are referred to as a filter pack

CC filters control the color of light that strikes the emulsion. They control the amount of light each emulsion layer receives during exposure. That results in the amount of color dyes formed in each emulsion layer. The overlapped colored dyes (cyan, magenta, and yellow in proper proportions) represent the colors of the original scene.

Color Printing Filters

Color printing (CP) filters are used in color printing, the same as CC filters with one exception. CP filters are placed in the enlarger between the light source and the negative or transparency being printed. That is done because CP filters are made of acetate and affect image definition.

CP filters are available in red, cyan, magenta, and yellow with densities of 0.05, 0.10, 0.20, and 0.40. The color of a filter and its peak density are identified the same as CC filters.

Ultraviolet Absorbing Filters

Ultraviolet absorbing filters for color printing prevent the fogging of the color material by ultraviolet radiation emitted by the exposing light source. This filter is not considered part of a printing filter pack, but it is always present in color printing systems. An ultraviolet absorbing filter for color printing is identified as 2B.

Dichroic Filters

Most photographic filters use colored dyes that absorb certain wavelengths and allow others to be transmitted. Such filters do not begin and end transmission at precise wavelengths.

Sharp-cutting, narrow-band filters are produced using wavelength interference rather than wavelength absorption. Dichroic or interference filters pass certain precise wavelengths and reflect all others.

Dichroic filters are used extensively in color printing and photographic testing systems. Because of their stability and long life, dichroic filters provide more accurate and more precise filtration.

HANDLING AND STORING OF FILTERS

A gelatin filter is protected by a thin lacquer coating that provides little protection against careless handling. Handle these filters carefully and only the edges. When not in use, gelatin filters should be stored in their original package, or they can be stored in clean paper between pages of a book. Gelatin filters should be kept flat and stored in a dark, dry place. Continued stress on gelatin filters can deform them permanently. When stored in high-humidity areas, they can become cloudy.

Dust particles should be removed from gelatin filters by brushing gently with a clean camel-hair brush or by clean, low-pressure air.

Glass filters or gelatin filters mounted between glass should be treated the same as photographic lenses. They should be kept in protective boxes or containers and should never be exposed to dampness or dirt. Never wash glass-mounted filters with water. When water comes in contact with the gelatin at the edges of a glass-mounted filter, it causes it to swell and allow air to enter between the gelatin and the glass. That causes a defect in the optical properties of the filter.

When a glass-mounted filter becomes dirty, you should not rub or breath on it. Use a piece of soft cloth or lens tissue moistened with lens cleaner. Do not allow the lens cleaner to touch the edges of the filter. Large pieces of grit should be removed with a camel's hair brush before attempting to clean the filter.

Do not expose gelatin or glass filters to temperatures higher than 122°F (50°C). High temperatures, high humidity, and time affect the stability of the dyes and shorten the life of the filter.

You should now have a basic understanding of filters and how they affect various wavelengths of tight. You should know the ways in which filters are used for exposing light-sensitive materials. Filters are an integral link to high-quality products. This knowledge provides you with an invaluable tool in filter application for all the various stages of the photographic processes.